Investigation of environmental disease outbreaks

By
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Lecture 6

An Outbreak?

An outbreak (or epidemic) is the occurrence of more cases of a disease than expected in a given area or among a specific group of people over a particular period of time.

- There is no general rule about the number of cases that must exist for an outbreak to be considered an epidemic. Rather, an epidemic exists when the number of cases exceeds that of what is expected on the basis of past experience for a given population.
  - For example, one case of smallpox would constitute an outbreak.
- An outbreak may encompass any time period. It may last a few hours (bacterial food poisoning), a few weeks (hepatitis) or several years (acquired immunodeficiency syndrome, or AIDS).

Definitions

- Endemic - usual number cases (persists, Hepatitis A)
- Pandemic - widespread epidemic (flu, AIDS)
- Sporadic - infrequent, irregular cases
- Cluster - group of cases closely related in time and place
- Incubation period - interval between exposure and onset signs/symptoms

Purpose of Investigation

- Control and prevent new cases
- Describe situation
- Identify contributing factors
- Identify and implement control measures
- Prevent recurrence

Why Epidemic Occur ?

1. When susceptible individuals travel into an endemic area where the infectious disease exists.

2. When a new infectious disease is introduced by humans or animals traveling from an endemic area into a susceptible human population in whom the disease is not endemic, or when contamination of food, water or other vehicles takes place by an agent not normally present, such as cyanide (a poison) introduced into Extra Strength Tylenol® accidentally or anthrax spores placed into mail as a terrorist act.

3. When a preexisting infection occurs in an area of low endemicity and reaches susceptible persons as a result of new or unusual social, behavioral, sexual or cultural practices. Examples include migration of refugees during war time and pilgrimages to religious places and churches.

4. When host susceptibility and response are modified by natural or drug-induced immunosuppression (cancer treatment), malnutrition or diseases such as AIDS.

Public health infrastructure in a country

- The county or city health department
  - The front line of public health
- The State health department
  - Epidemiologists
  - Laboratorians
  - Sanitarians
- The federal agencies:
  - Risk identification agency: CDC
  - Risk management/regulatory agencies: FDA, USDA, EPA
- "Tiered response" to emergencies
  - CDC provides back-up to States: epidemiologists, laboratory support, coordination

Federal Roles

CDC:

- Disease surveillance
- Outbreak detection and investigation
- Education and training of public health staff

- FDA:
  - Food safety policies
  - Inspection and enforcement
  - Product recall and traceback
  - Investigation of farm and production facilities

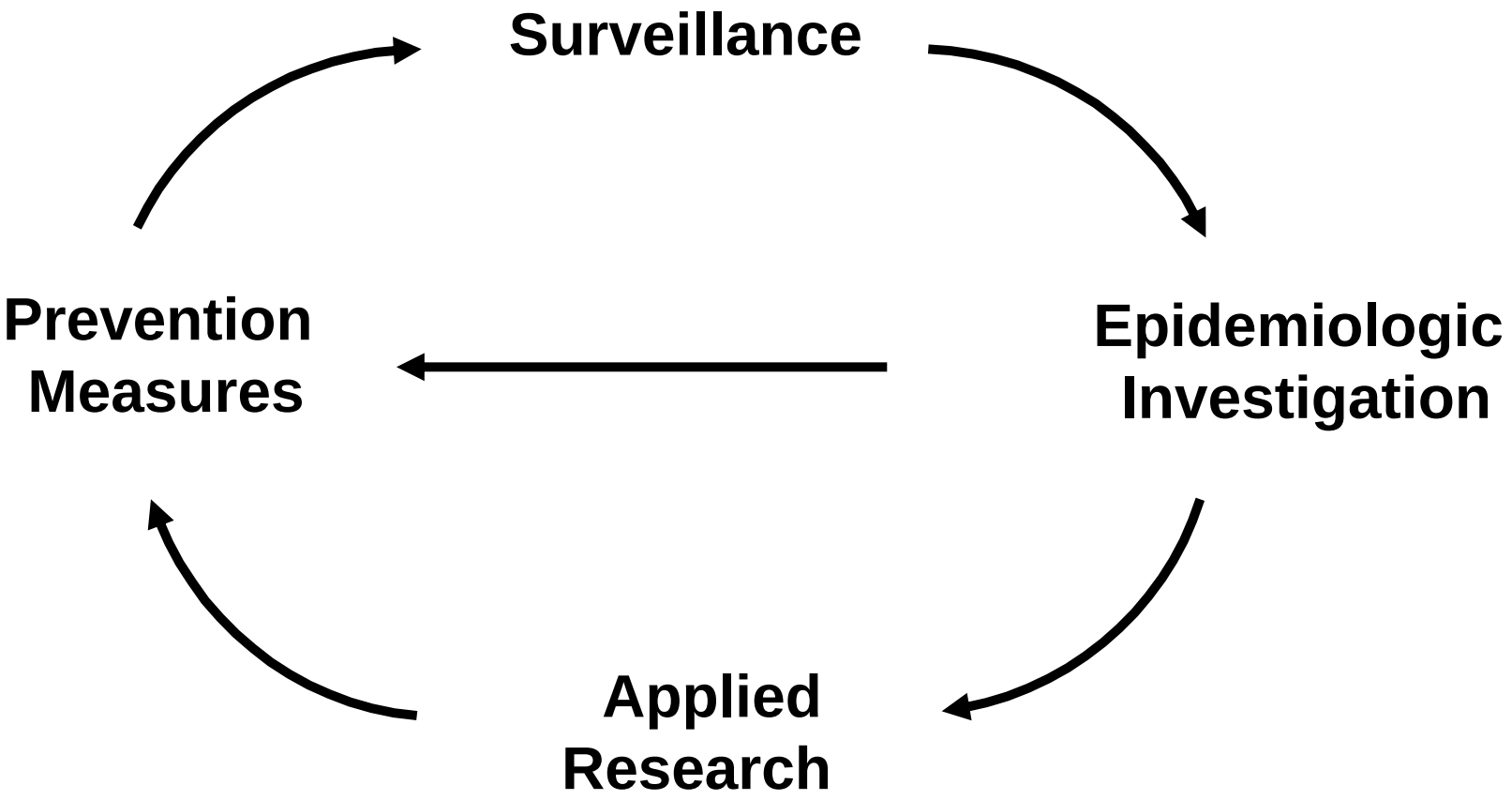
Problem identification

Source implication

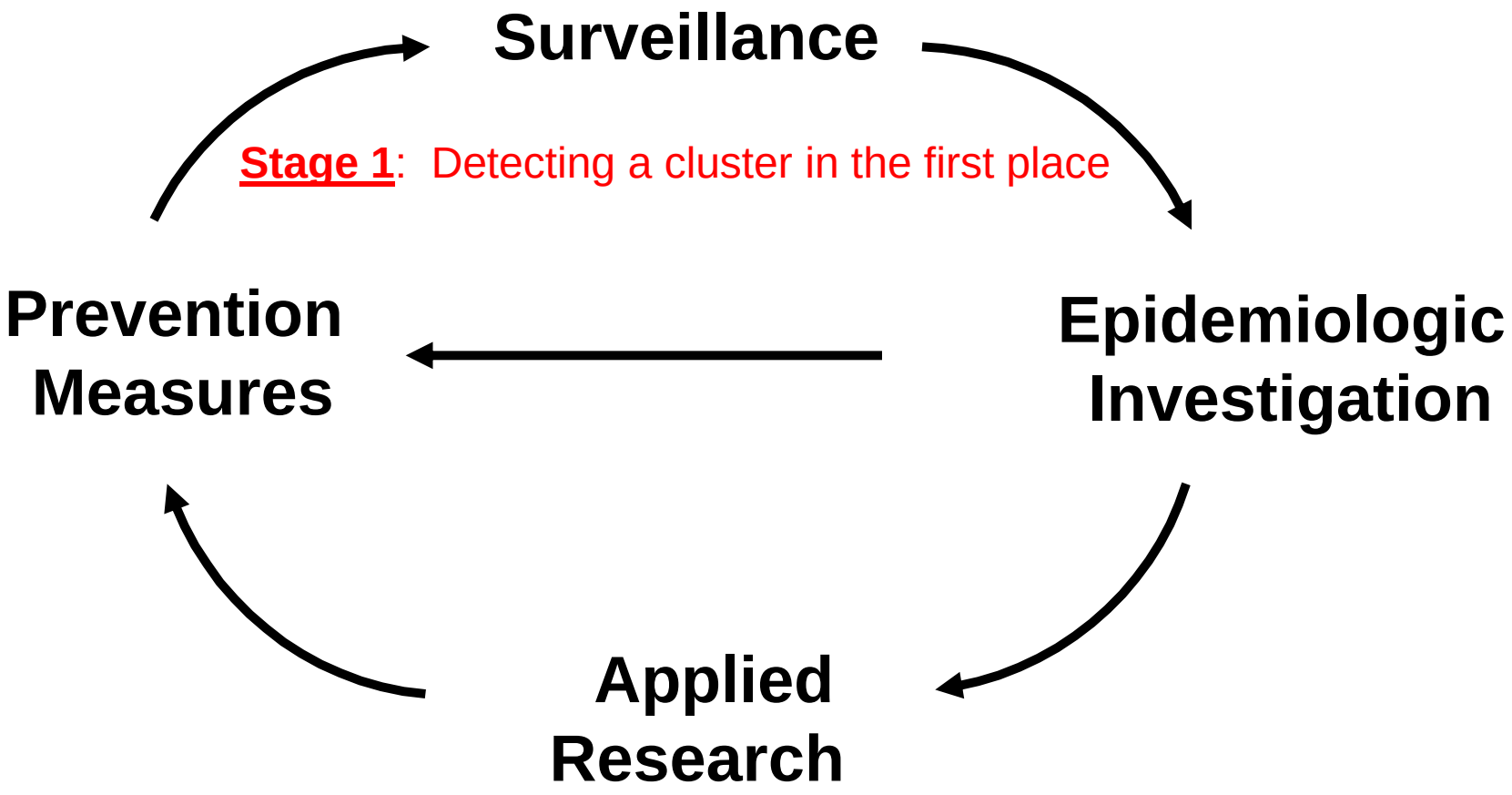
Risk assessment and management

Source assessment

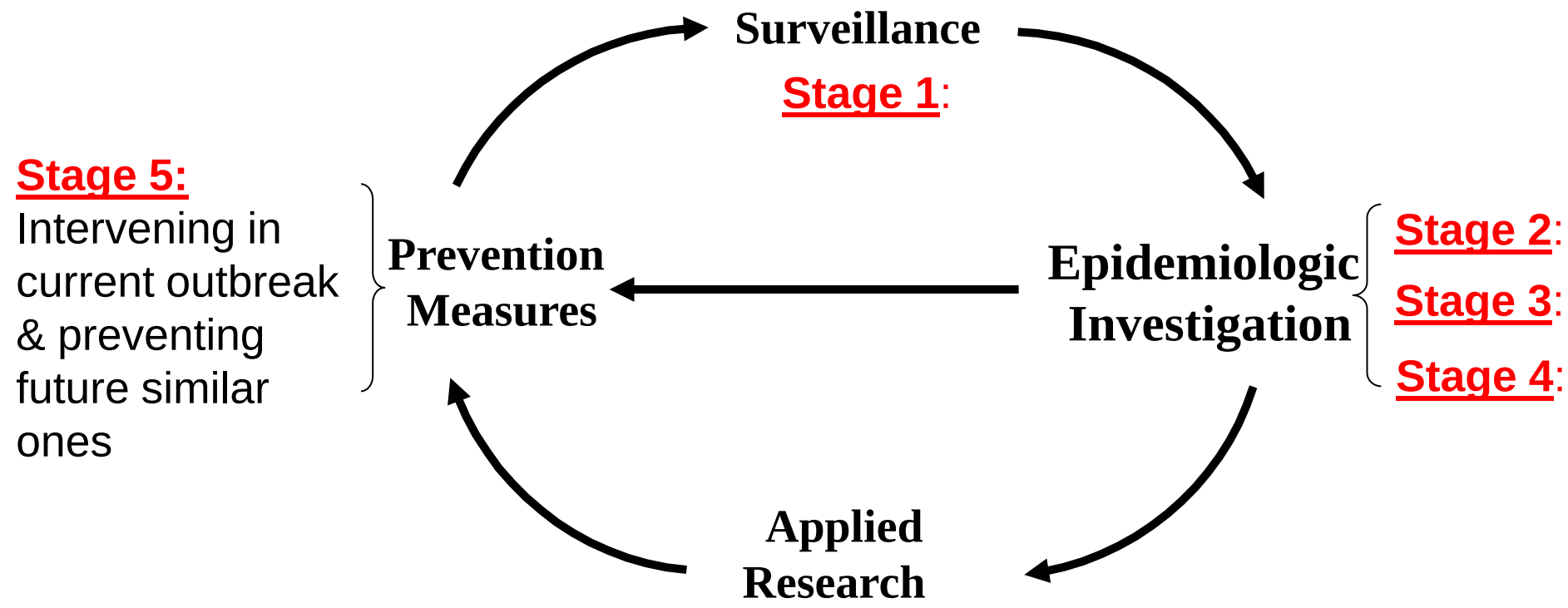
Cycle of Food-borne Disease Control and Prevention



Cycle of Food-borne Disease Control & Prevention: Stages of an Outbreak Investigation



Cycle of Foodborne Disease Control & Prevention: Stages of an Outbreak Investigation



Outbreak Investigation Tasks

Step 1: Verify Diagnosis

- Goal is to rule out:
  - misdiagnosis
  - laboratory error
- Examine case-patient(s)
- Review medical records
- Confirm laboratory findings

Step 2: Verify Existence of Outbreak

- Endemic vs epidemic
- Establish baseline (expected number/rate)
- Compare observed number with baseline
- Is observed > expected ?
- Rule out pseudoepidemic

Initial Evaluation

- Evaluate severity of problem
- Begin search for other cases
- Start line-listing
- Review existing data
- Identify and implement early control measures

Line-Listing

Cases

Name	Record #	Age	Room/ Unit	Date Admit	Date culture	Specimen	CA	HA

Outbreak Investigation Tips

- Do literature search
- Notify others
- Report outbreak to health dept.
- Assemble team - Need outside help?
- Appoint spokesperson (communicate!)
- Notify lab: save isolates, sera, or specimens

Outbreak Investigation Tips

- Decide on basic or full scale investigation
- Consider full-scale investigation if:
  - serious disease
  - commercial product involved
  - widespread problem
  - unique situation

Step 3: Define & Identify Cases

- Develop case definition
- Search retrospectively
- Search concurrently
- Asymptomatic cases?
- Encourage reporting
- Add new cases to line-listing

Outbreak Investigation Tips

- Create data collection form:
  - one form per case
  - include only information needed
  - avoid wasting time collecting too much information
  - avoid missing data later found needed
- Data collection form may include:
  - case identification information
  - demographic information
  - clinical information
  - risk factors

Step 4: Orient Data

- Person
  - identify cases & population at risk
  - determine risk factors
- Place
  - limited or facility-wide?
- Time
  - determine date onset
  - draw epidemic curve

Step 5: Formulate Hypothesis

- Observe practices
- Review data. Determine nature of organism and base hypothesis on likely:
  - Source or reservoir
  - Mode of transmission
  - Exposures or risk factors

Step 6: Evaluate Hypothesis

- Compare hypothesis with facts
- Conduct study to compare rates of disease between two groups
    - case-control study
    - retrospective cohort study

- Consult a statistician !!!

Step 7: Refine Hypothesis/ Conduct Additional Studies

- Is hypothesis confirmed? Do you need:
  - Additional statistical studies
  - Additional laboratory studies
  - Additional cultures
    - environment
    - personnel
    - patients or residents

Step 8: Evaluate Control Measures

- Make recommendations for control measures based on:
  - causative agent
  - source and reservoir
  - mode of transmission
  - susceptibility to agent

Evaluate effectiveness of measures

Step 9: Communicate Findings (1)

Effective Communication is
the Key
to Stopping an Outbreak

Step 9: Communicate Findings (2)

- Oral briefings
- E-mail
  - update findings
  - recommend control measures
  - delineate responsibilities
- Written reports
- Meetings
  - take & distribute minutes

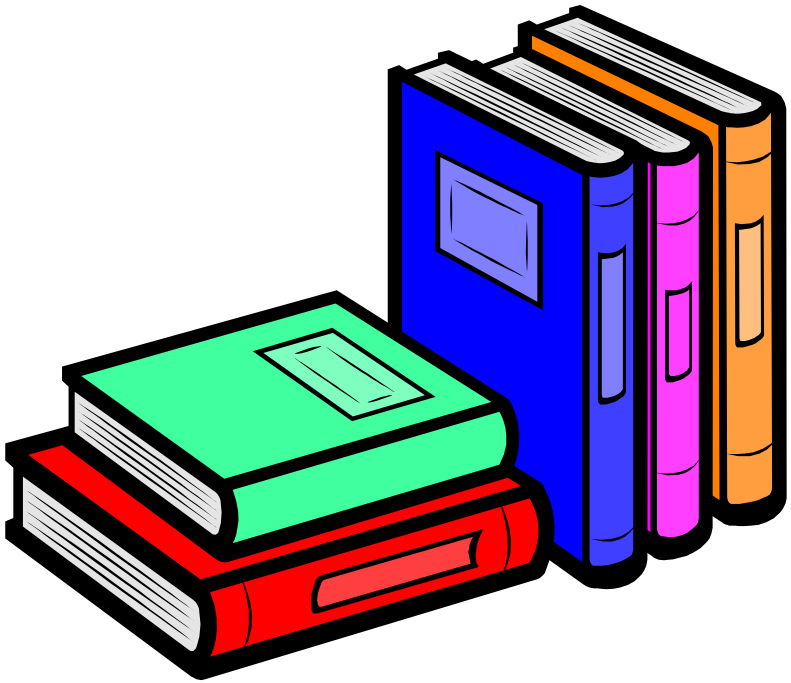
Step 9: Communicate Findings (3)

Distribute final written report

- introduction
- method
- results - facts only
- discussion - interpret findings
- summary
- recommendations
- distribution of report
- author name(s) and title(s)

Outbreak Investigation

Publish your findings !



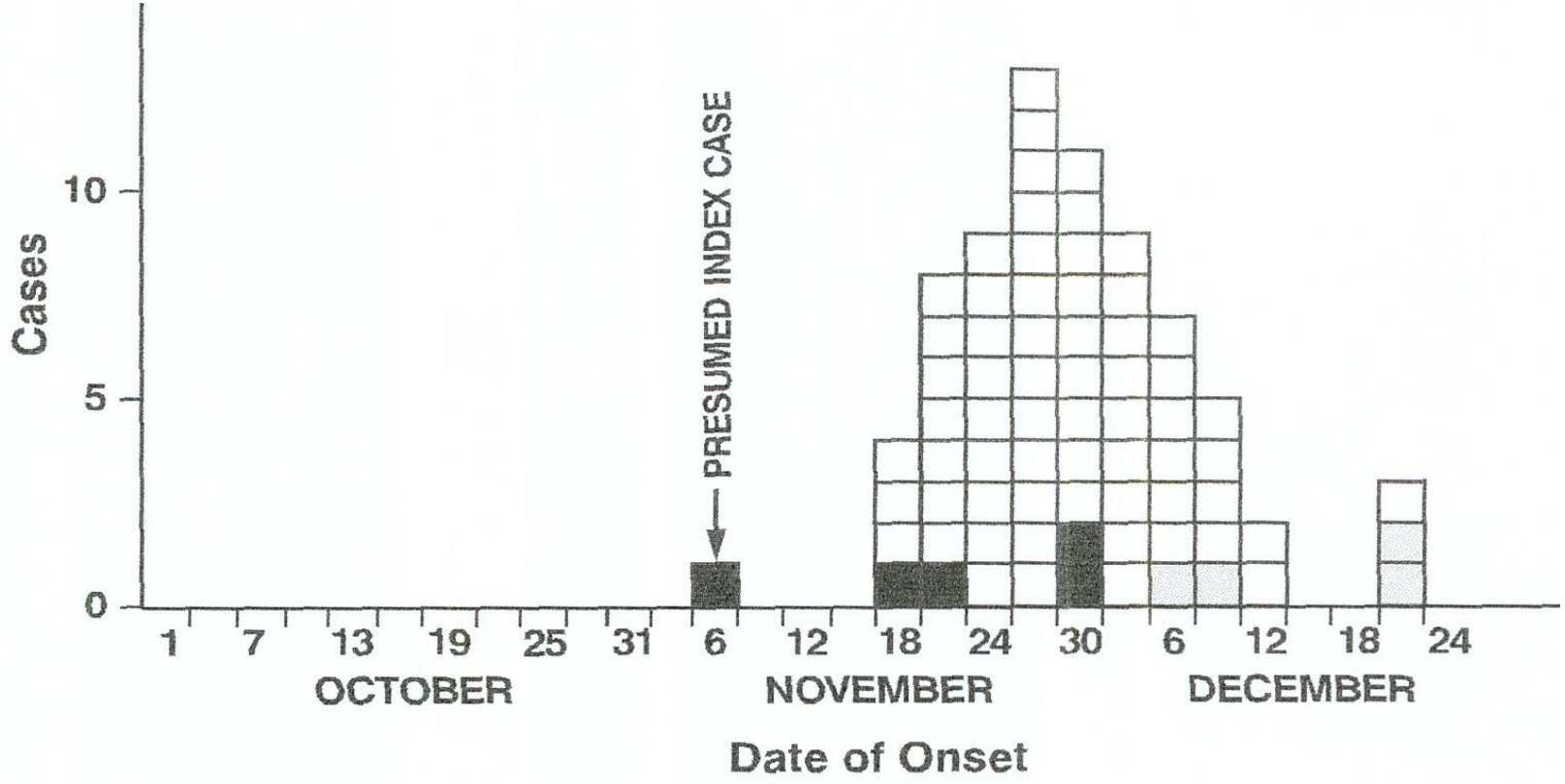
Limitations of the Epidemiological Method

- Depends on information a person knows – if they are not aware of exposure they cannot report it
- Needs sufficient number of cases and controls to achieve statistical power
- If the correct hypothesis is not considered, it may not be found – may need to repeat the process
  - Partial traceback may be required to test hypotheses
- Implicates the food actually eaten – not necessarily the original source
- Spurious associations are possible:
  - By chance alone, (probability) or
  - Because the implicated food is connected to the unrecognized true source (confounding)

Laboratory Testing of Food in an Outbreak Investigation

- Can be very useful as demonstration that a particular food was contaminated
- Can be critical if the number of patients is very small, and statistical power of epidemiology is low
- Occasionally can provide the critical break information
- May not identify the pathogen in the implicated product because:
  - The actual food that caused the outbreak was already consumed, and thus not collected
  - The food that caused the outbreak was overlooked when samples were collected
  - Contamination may be variable within a food
  - The pathogen may not survive long in the food
  - The test may be insensitive or unverified, the lab may be unqualified
  - There may be no assay at all for that pathogen
  - Laboratory error

The Epidemic Curve



A graph (histogram): provides visual display of outbreak's magnitude (# cases) and time trend

Shape of Epidemic Curve

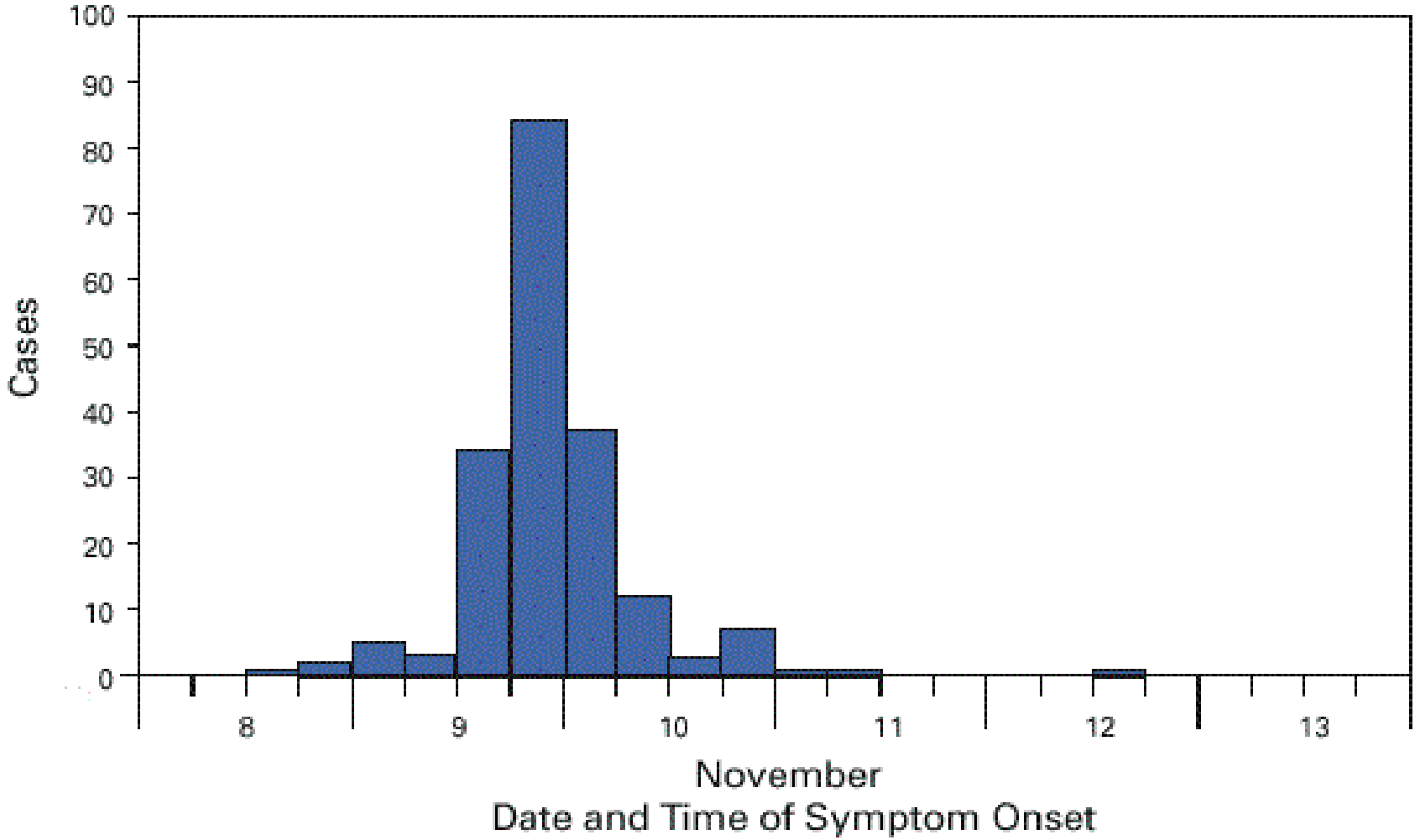
- Overall shape determined by:
- time period of exposure
- minimum, average, and maximum incubation periods of disease
- outbreak pattern
  - common source or propagated

Common Source Outbreaks

- Common source
  - point source
    - cases exposed over brief time period
    - all cases occur within one incubation period
  - continuous
    - cases exposed over prolonged time period or intermittently

Common Source: Point Source Exposure

FIGURE 1. Number of cases of Norwalk-like viral gastroenteritis among company employees, by date and time* of symptom onset — Anchorage, Alaska, November 8–13, 1999



*6-hour intervals.

Common Source: Intermittent Exposure

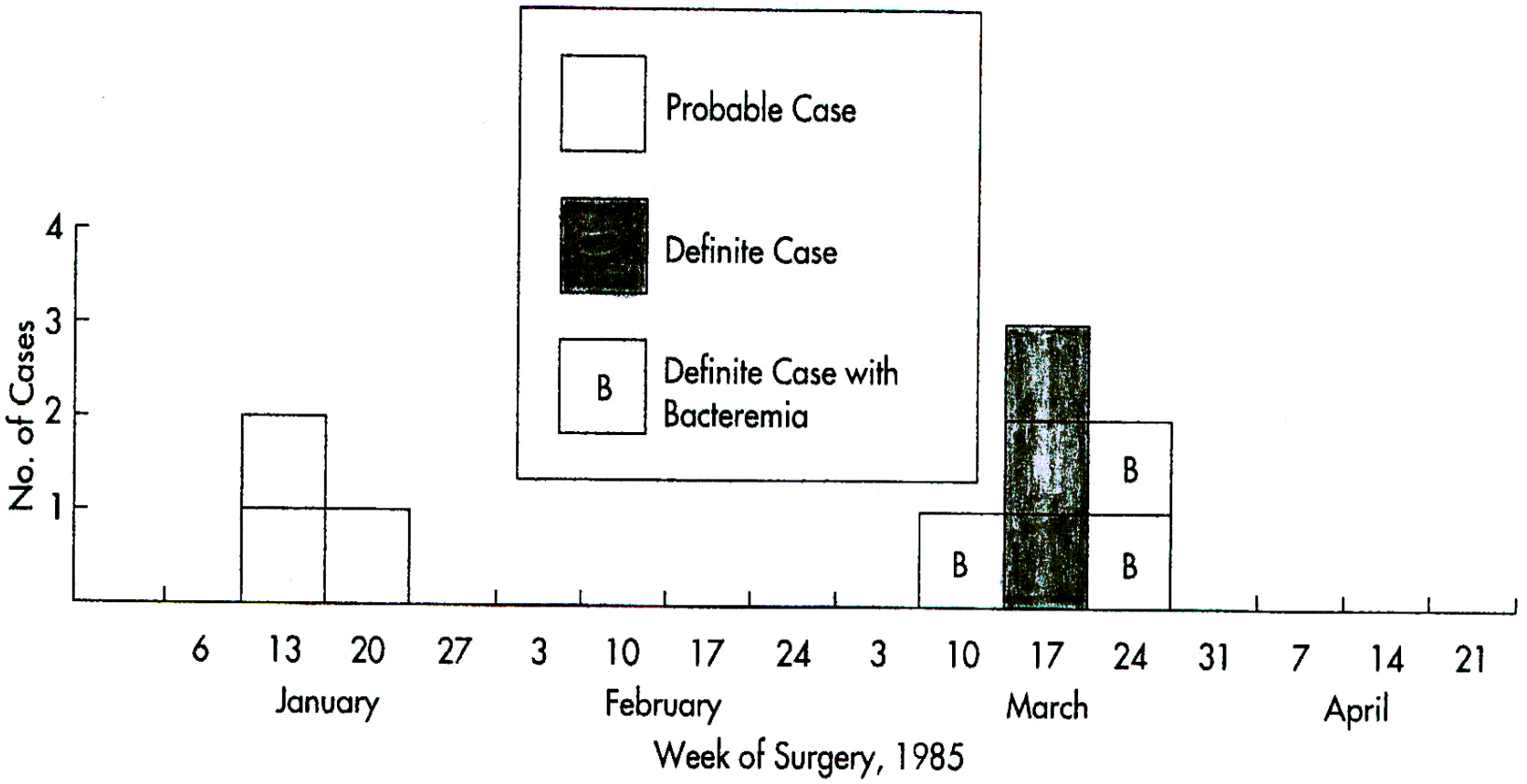


Figure 15-3 Epidemic curve for outbreak of *Pseudomonas pickettii* bacteremias and contaminated infusate traced to contaminated fentanyl.

Point Source Epidemic Curve: Can Identify Likely Period of Exposure

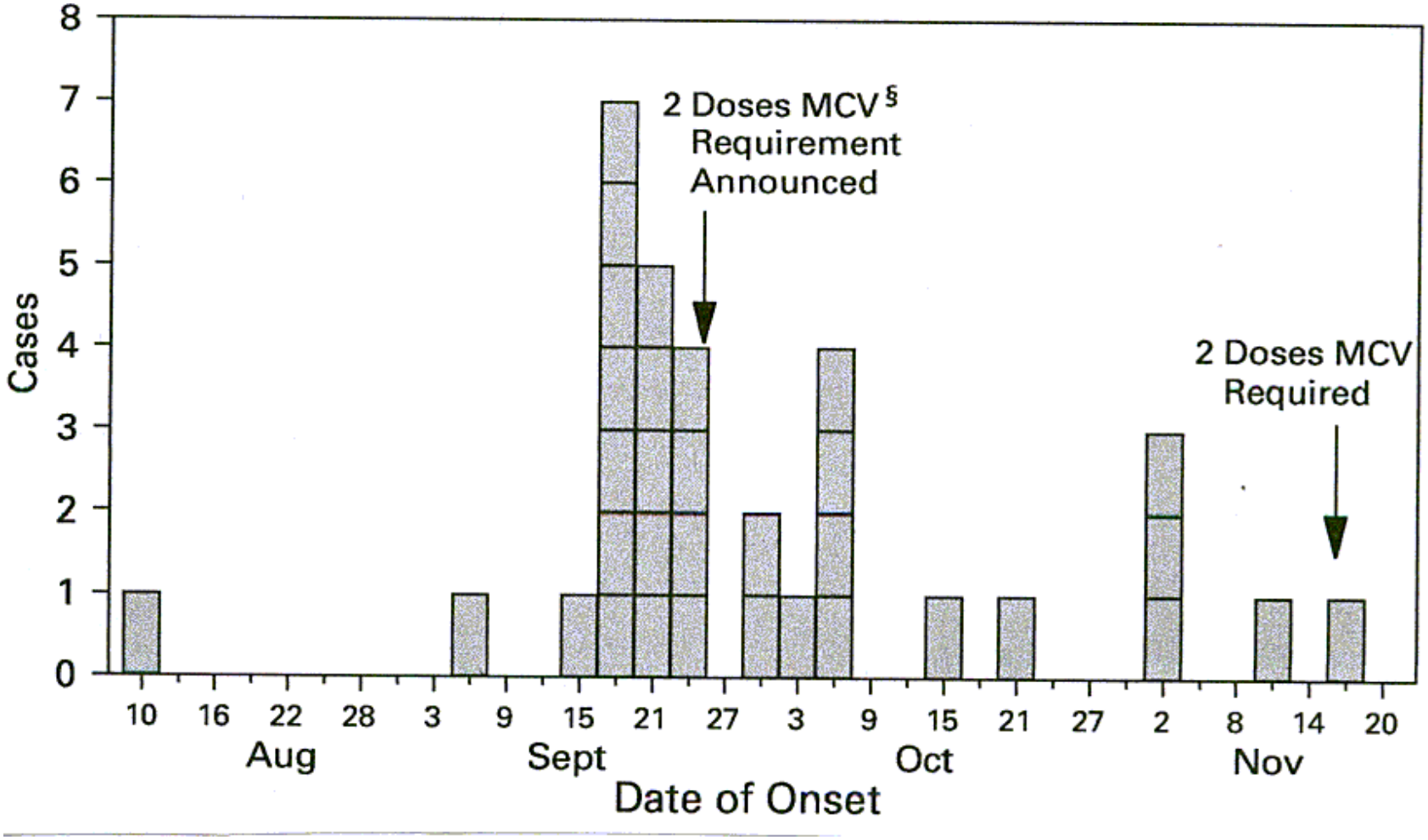
- Identify minimum and average incubation periods (must know likely etiologic agent)
- Identify peak or median case and count back on *x*-axis average incubation period. Note date.
- Identify earliest case and count back minimum incubation period. Note date.
- Exposure likely occurred around these dates

Propagated Outbreak

Propagated

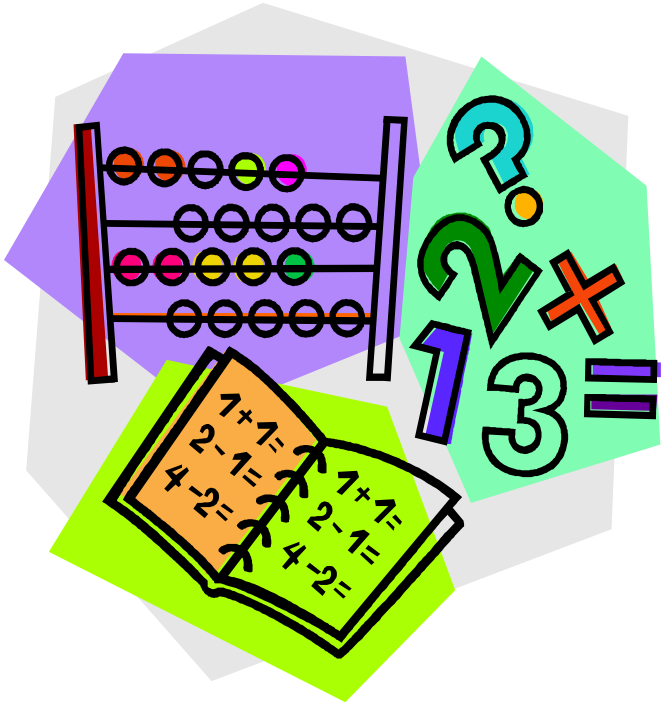
- disease spreads from person to person
- continuing, not attributed to common source
- explosive epidemics

Propagated Outbreak



Statistical Methods Used

- Descriptive
  - Frequency measures (rates)
- Analytic studies
  - case control or cohort
- Measures of association
  - odds ratio or risk ratio
- Tests of statistical significance
- Confidence Intervals



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